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TRANSMITTAL FORM

(to be used for all correspondence after initial filing)

Application Number	10/810,452
Filing Date	03/26/2004
First Named Inventor	Sehat Sutardja
Art Unit	2838
Examiner Name	Bao Q. Vu
Total Number of Pages in This Submission	
Attorney Docket Number	MP0467

ENCLOSURES *(check all that apply)*

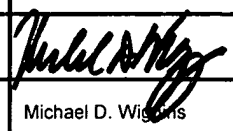
- ☐ Fee Transmittal Form
  - ☐ Fee Attached
- ☐ Amendment / Reply
  - ☐ After Final
  - ☐ Affidavits/declaration(s)
- ☐ Extension of Time Request
- ☐ Express Abandonment Request
- ☐ Information Disclosure Statement
- ☐ Certified Copy of Priority Document(s)
- ☐ Response to Missing Parts/ Incomplete Application
  - ☐ Response to Missing Parts under 37 CFR 1.52 or 1.53
- ☐ Drawing(s)
- ☐ Licensing-related Papers
- ☐ Petition
- ☐ Petition to Convert to a Provisional Application
- ☐ Power of Attorney, Revocation Change of Correspondence Address
- ☐ Terminal Disclaimer
- ☐ Request for Refund
- ☐ CD, Number of CD(s) _____
- ☐ After Allowance Communication to Technology Center (TC)
- ☐ Appeal Communication to Board of Appeals and Interferences
- ☒ Appeal Communication to TC **(Appeal Notice, Brief, Reply Brief)**
- ☐ Proprietary Information
- ☐ Status Letter
- ☒ Other Enclosure(s) *(please identify below)*:

  Communication; and Return receipt postcard.

Remarks

The Commissioner is hereby authorized to charge any additional fees that may be required under 37 CFR 1.16 or 1.17 to Deposit Account No. 08-0750.

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm Name	Harness, Dickey & Pierce, P.L.C.		
Signature			
Printed name	Michael D. Wiggins		
Date	March 18, 2008	Reg. No.	34,754

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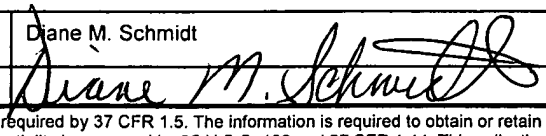
Signature		Date	March 18, 2008

This collection of information is required by 37 CFR 1.5. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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EM 184 987 098 US

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.:	10/810,452
Filing Date:	March 26, 2004
Applicant:	Sehat Sutardja
Group Art Unit:	2838
Examiner:	Bao Q. Vu
Title:	VOLTAGE REGULATOR
Attorney Docket:	MP0467

Director of the United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450

COMMUNICATION

Sir:

This response is in regard to the Office Action dated October 19, 2007.

As stated by Examiner Bao Q. Vu in the above subject Office Action, Paragraph 1. (2) "The previously paid notice of appeal fee and appeal brief fee can be applied to the new appeal." Accordingly, please apply the previously paid fees to the present appeal brief.

CONCLUSION

If the Examiner believes that personal communication will expedite prosecution of this application, the Examiner is invited to telephone the undersigned at (248) 641-1600.

Respectfully submitted,

Dated: 3/18/08

By: _____
Michael D. Wiggins
Reg. No. 34,754

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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.:	10/810,452
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Attorney Docket:	MP0467

BRIEF FOR APPELLANT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

This Appeal is from the decision of the Patent Examiner dated October 19, 2007, rejecting Claims 1, 4-11 and 14-29, which are reproduced as an Appendix to this Appeal Brief.

TABLE OF CONTENTS

I. Real Party in Interest

The entire interest in the present application, and the invention to which it is directed, was assigned from the inventors to Marvell Semiconductor Inc. at Reel 015159, Frame 0454, from Marvell Semiconductor Inc. to Marvell International Ltd. at Reel 015157, Frame 0923, and from Marvell International Ltd. to Marvell World Trade Ltd. at Reel 015790, Frame 0156.

II. Related Appeals and Interferences

An Appeal Brief was previously filed on May 21, 2007. The Appellants' legal representative and assignee do not know of any other appeals or interferences which will directly affect, or be directly affected by, or have a bearing on the Board's decision in this Appeal.

III. Status of Claims

The present application contains claims 1, 4-11 and 14-29, all of which are currently pending and form the basis for this Appeal. Claims 1, 4-11, and 14-29 stand rejected.

IV. Status of Amendments

No amendments or responses were filed subsequent to Final Office Action dated October 19, 2007 other than the Notice of Appeal.

V. Summary of the Claimed Subject Matter

Switching regulators are widely used to provide voltage regulation in electronics sub-systems. A switching regulator may generate an output voltage by generating a pulse output from an input voltage. The pulse output is generally filtered by a low pass filter to generate a DC output voltage. The amplitude of the DC output voltage may be regulated by varying the pulse

width of the pulses that comprise the pulse output or controlling the on-time or the off-time of the pulse output.

A significant portion of power loss in a switching regulator occurs in the power switches that generate the pulse output from the input voltage. The power switch losses may be divided between conduction losses and switching losses. As the pulse width decreases in proportion to the switching frequency of the pulse output, the switching losses may increase relative to the conduction losses. In addition, at narrower pulse widths such as a 10% duty cycle, maintaining regulation of the output voltage may become more difficult resulting in increased error in the output voltage.

Figure 1A of Applicant's specification shows an exemplary conventional voltage regulator 10 for converting an input voltage to an output voltage Vout. A conduction switch 12 and freewheeling switch 14 may convert the input to a pulse output. For example only, the input voltage can be 12 Volts and the output voltage can be 1.2 Volts.

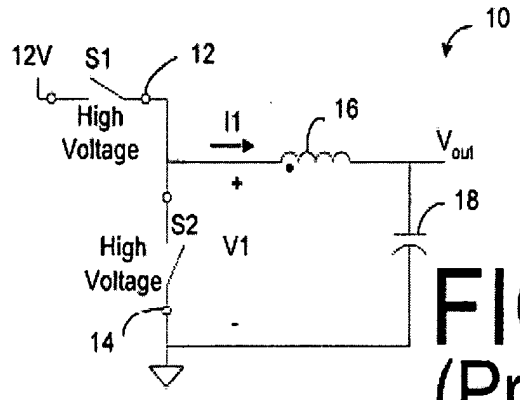


FIG. 1A
(Prior Art)

The conduction switch 12 and freewheeling switch 14 are generally selected to be **high voltage devices to withstand the entire input voltage**.

The pulse output may be filtered by an output inductor 16 and output capacitor 18 to form

Vout. Figure 1B of Applicant's specification shows waveforms associated with the conventional voltage regulator 10. Waveform 20 shows the operating state of the conduction switch 12. Waveform 22 shows the voltage V1 across the freewheeling switch 14. Voltage V1 may typically have a rise time and a fall time of about 10 nsec. The rise time and fall time are typically limited by the type of switches used for the conduction switch 12 and the freewheeling switch 14. The switching losses may increase as the rise time and fall time increase. Waveform 24 shows the current I1 flowing through the output inductor 16. As the pulse width continues to decrease, switching losses become a greater proportion of the total power losses.

Alternate prior art voltage regulators are also described in Qian U.S. Pat. No. 6,512,352. In a prior art circuit in FIG. 2 of Qian, Qian discloses a circuit that is similar to Applicant's claimed circuit:

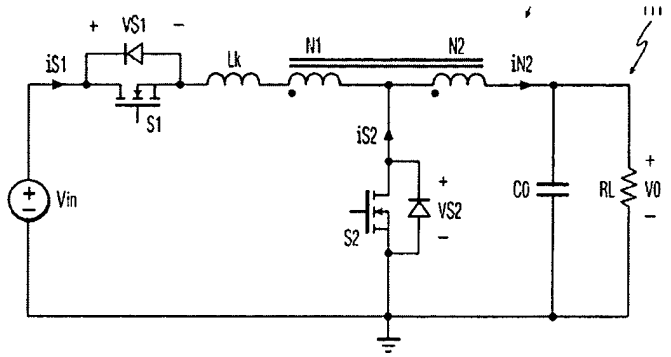


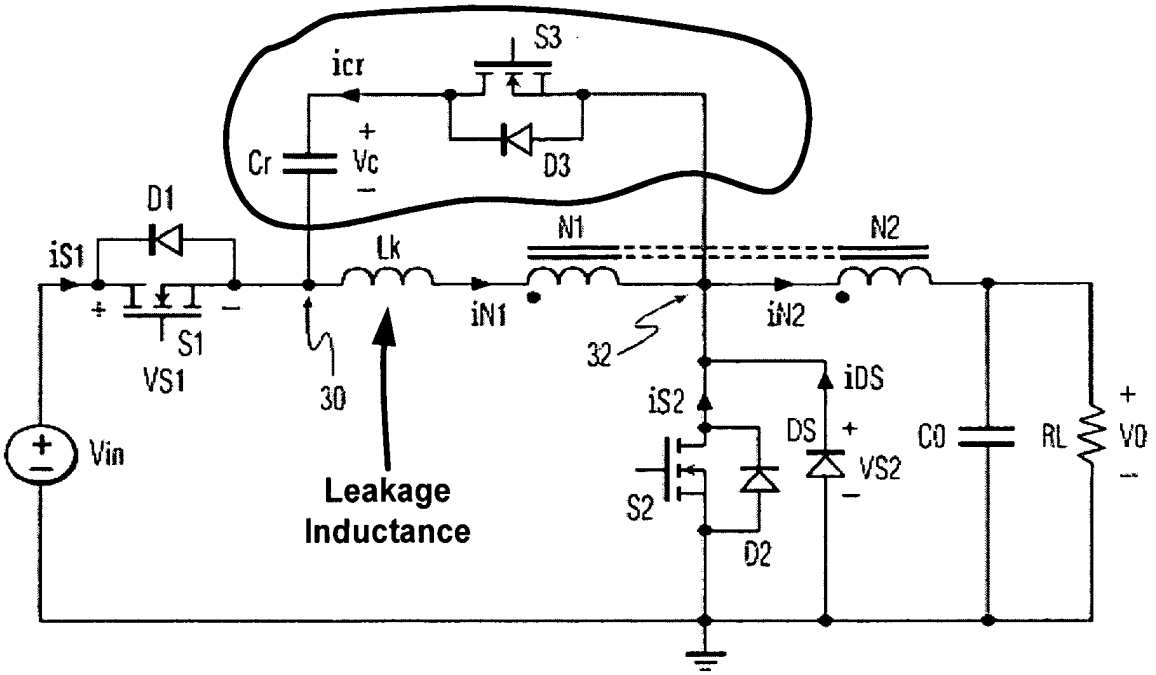
FIG. 2
PRIOR ART

Primary differences between Applicant's claimed circuit and this circuit include:

1. A different type of coupled inductor in that the coupled inductor has a coefficient of coupling that is at least 0.99; and

2. The turns ratio of the coupled inductor is at least 2.

The improvement disclosed by Qian in FIG. 4 is set forth below:



Qian essentially added the diode DS and the other circled components to the prior art circuit of FIG. 2.

Briefly, both FIGs. 2 and 4 of Qian '352 are directed towards solving problems associated with leakage inductance L_k associated with a coupled inductor that is not tightly coupled. To that end, Qian includes a circuit **(that is circled above in FIG. 4)** to compensate for the leakage inductance L_k of the coupled inductors in the prior art circuit of FIG. 2.

Applicant used a tightly coupled inductor having a coefficient greater than or equal to 0.99 to reduce the stress on the switches. Applicant also employs the turns ratio to further reduce the voltage demands on the switches, A voltage regulator 30 in FIG. 2A of Applicant's application supplies power to one or more devices such as high-speed drivers and other electronic devices. A conduction switch 32 may switch between an on-state and an off-state at a switching frequency to apply the input voltage to a coupled inductor 36. During the off-time,

the entire input voltage may be impressed across the conduction switch 32. Therefore the conduction switch 32 should have a withstanding voltage that is greater than the input voltage.

A freewheeling switch 34 may provide a path for current flowing in the coupled inductor 36 when the conduction switch 32 is in the off-state. Due to the operation of the coupled inductor 36, less than the entire input voltage is impressed across the freewheeling switch 34 during operation of the voltage regulator 30. Thus, the freewheeling switch 34 may have a withstanding voltage less than the input voltage.

The current flowing through the coupled inductor 36 may be filtered by an output capacitor 38 to form V_{out}. A drive signal generator 31 may generate a drive signal to control the conduction switch 32. The drive signal generator 31 may also generate a drive signal to control the freewheeling switch 34 if a controllable switch such as a FET is used as the freewheeling switch 34.

Switches that have a lower withstanding voltage typically have a lower Rds(on) or Vce(sat) than a switch with a comparable die size and a higher withstanding voltage. The lower Rds(on) or Vce(sat) may result in lower conduction losses. In addition, the switching losses may also be lower due to the lower voltage impressed across the freewheeling switch.

With a turns ratio of 2, the duty cycle of the voltage regulator is approximately two times greater than the duty cycle for the standard topology buck converter, current flowing through the coupled inductor 36a is approximately one-half the amplitude, and the voltage impressed across the drain-source of the freewheeling switch 34a is less than the voltage impressed across the drain-source of the standard topology buck converter. The voltage impressed across the drain-source of the freewheeling switch converter 34a is approximately:

$$Vds \cong (Vin - Vout) * \left(\frac{N2}{N1 + N2} \right) + Vout$$

In contrast, in a standard topology buck converter the voltage impressed across the drain-source of the freewheeling switch is approximately, $V_{ds} = V_{in}$.

The table set forth below provides support in the specification and drawings for independent Claims 1 and 11:

Claim 1	Specification
A voltage regulator for generating an output voltage from an input voltage, comprising:	At least paragraph [0016] and FIGs. 2A-4.
at least one coupled inductor **36** including a first winding **N1** and a second winding **N2** each having a polarity, the first winding **N1** and the second winding **N2** connected in series to form a common node and such that the first winding **N1** and the second winding **N2** have the same polarity, the first winding and the second winding having a coefficient of coupling greater than or equal to 0.99;	At least paragraphs [0016] and [0023] and FIGs. 2A, 2C, 4.
a conduction switch **32** having an on-state and an off-state, to controllably conduct the input voltage to the at least one coupled inductor **36** at a switching frequency; and	At least paragraph [0016] and FIGs. 2A, 2C, 4.
a freewheeling switch **34** having an on-state and an off-state, in communication with the common node of the at least one coupled inductor **36** to provide a path for current when the conduction switch is in the off-state,	At least paragraph [0016] and FIGs. 2A, 2C, 4.
wherein the first winding has a number of turns N1, the second winding has a number of turns N2 and a turns ratio N1/N2 is at least two.	At least paragraph [0021] and FIGs. 2A, 2C, 4.

Support for independent Claim 11:

Claim 11	Specification
A voltage regulator for generating an output	At least paragraph

voltage from an input voltage, comprising:	[0016] and FIGs. 2A-4.
at least one coupled inductor **36** including a first winding **N1** and a second winding **N2** each having a polarity, the first winding **N1** and the second winding **N2** connected in series to form a common node and such that the first winding **N1** and the second winding **N2** have the same polarity, the first winding **N1** and the second winding **N2** having a coefficient of coupling greater than or equal to 0.99;	At least paragraphs [0016] and [0023] and FIGs. 2A, 2C, 4.
means for conduction switching **32** having an on-state and an off-state, to controllably conduct the input voltage to the at least one coupled inductor **36** at a switching frequency; and	At least paragraph [0016] and FIGs. 2A, 2C, 4.
means for freewheeling switching **34** having an on-state and an off-state, in communication with the common node of the at least one coupled inductor **36** to provide a path for current when the conduction switching means **32** is in the off-state,	At least paragraph [0016] and FIGs. 2A, 2C, 4.
wherein the first winding has a number of turns N1, the second winding has a number of turns N2 and a turns ratio N1/N2 is at least two..	At least paragraph [0021] and FIGs. 2A, 2C, 4.

VI. Grounds of Rejection to be Reviewed on Appeal

The final Office Action presents four grounds of rejection for review in this Appeal:

1. Claims 1, 4, 5, 6, 9, 11, 14, 15, 16, 19, 21 and 23 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Qian (U.S. Pat. No. 6,512,352) in view of Lu et al (U.S. Pat. No. 5,636,107). This rejection is respectfully traversed.

2. Claims 7 and 17 are rejected under 35 U.S.C. § 103(a) as being unpatentable over

Qian in view of Lu et al and further in view of Beckman et al. (U.S. Pat. No. 6,184,666). This rejection is respectfully traversed.

3. Claims 10, 22, 20, 24 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Qian in view of Lu et al and further in view of Yang et al. (U.S. Pat. No. 6,404,175). This rejection is respectfully traversed.

4. Claims 8, 18 and 25-29 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Qian in view of Lu et al and further in view of Dwelley et al. (U.S. Pat. No. 6,166,527). This rejection is respectfully traversed.

VII. Arguments

A. The Examiner's rejection of Claims 1, 4, 5, 6, 9, 11, 14, 15, 16, 19, 21 and 23 under 35 U.S.C. § 103(a) as being unpatentable over Qian (U.S. Pat. No. 6,512,352) in view of Lu et al (U.S. Pat. No. 5,636,107) is improper and should be withdrawn.

1. Claim 1.

With respect to Claim 1, both Qian and Lu fail to show, teach or suggest a coupled inductor having first and second windings, wherein the first winding and the second winding have a coefficient of coupling that is greater than or equal to 0.99.

The Qian reference **teaches away** from using a tightly coupled inductor. As best understood by Applicant, Qian addresses the situation where the coupled inductors have a **SIGNIFICANT** leakage inductance (represented by L_k) that causes **HIGH** voltage spikes across the switches. **The Examiner admits that Lu does not address this issue.**

Qian presents a prior art circuit in FIG. 2 and shows leakage inductance L_k of the coupled

inductor. FIG. 2 is set forth below with the leakage inductance identified using an arrow:

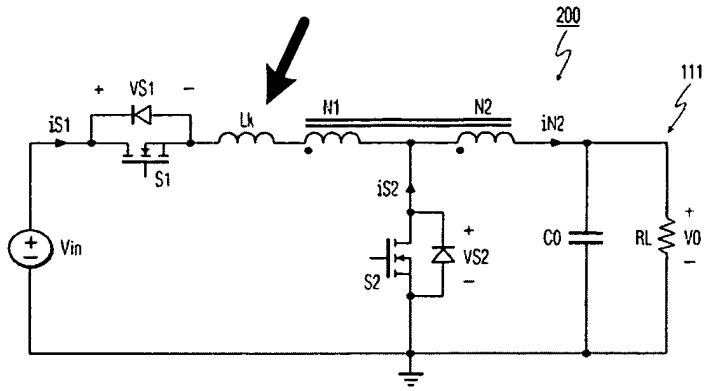
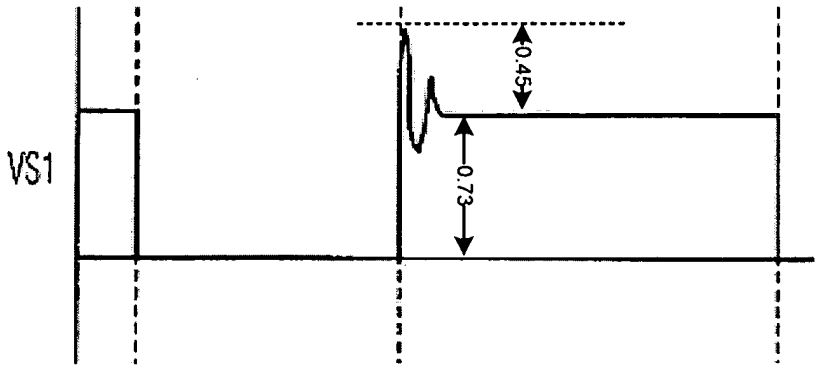


FIG. 2
PRIOR ART

L_k is not a discrete element in the circuit of prior art FIG. 2 but is an equivalent element representing leakage inductance L_k of the coupled inductors. In FIG. 3e, Qian shows the voltage spikes that occur in the prior art FIG. 2 as a result of the significant leakage inductance L_k in the prior art circuit of FIG. 2.

In FIGs. 3a-3f of Qian, large voltage spikes due to the leakage inductance L_k are shown that occur in the prior art circuit of FIG. 2 when the switch S1 is turned off and S2 is turned on. The voltage spikes swing to a voltage that is approximately 160% of the nominal voltage value. FIG. 3e (with added notations) of Qian is set forth below:



Qian states in Col. 2, lines 55-63:

> One disadvantage of circuit 200 is that a high voltage spike occurs across switch S1 when S1 turns off (e.g., at time t2, See FIG. 3E) **because the leakage energy of winding N1 cannot be transferred to winding N2. The leakage energy in L_k charges the output capacitance (not shown) of S1 through conducting switch S2 which causes a high voltage stress across S1.** As a result, a high voltage rated MOSFET switch must be used in the circuit 200 which significantly increases the power loss and reduces the efficiency.

As best understood by Applicant, the voltage swing that occurs as a result of the leakage inductance L_k appears to support the idea that while the inductors of Qian may be coupled, they are not **tightly** coupled in a manner as claimed. Furthermore, the switch S1 in prior art FIG. 2 of Qian must be able to withstand 160% of the input voltage rather than merely the input voltage as in Applicant's voltage regulator.

In response to these arguments, the Examiner alleges that Applicant has misconstrued the prior art by relying on prior art description of FIG. 2 in Qian. **See Final Office Action** mailed November 22, 2006, page 5 at paragraph 7. The Examiner alleges that "the prior art description is different than that of the invention being claimed in Qian." Applicant respectfully asserts that the Examiner is **incorrect** on this point.

The circuit in FIG. 4 of Qian **also** uses all of the elements of the prior art circuit of FIG. 2 – including the coupled inductors with leakage inductance L_k. Therefore the description of FIG. 2 is equally applicable to FIG. 4 – contrary to the Examiner's assertion.

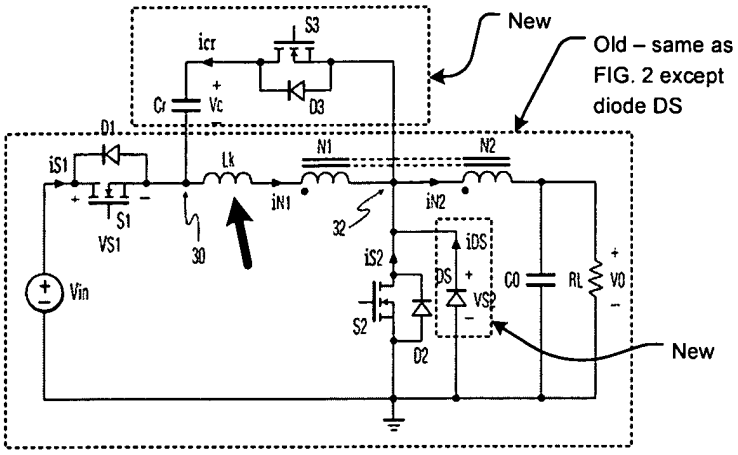


FIG. 4

There is **no discussion** in Qian that the coupled inductors in FIG. 4 are different than those in the prior art circuit of FIG. 2. In fact, Qian uses the exact same symbols.

Furthermore, the **whole point** of the improvement of Qian was to add the additional components to the prior art circuit of FIG. 2 **to compensate** for the leakage inductance L_k and to handle the voltage spikes that arise in the prior art circuit of FIG. 2.

In paragraphs 8-10 of the Final Office Action dated November 22, 2006, the Examiner incorrectly alleges that Applicant's response amounts to general allegations and fail to clearly point out patentable novelty. Applicant has clearly and consistently pointed out the reasons why **Qian does not disclose tightly coupled inductors** as expressly set forth in Claim 1.

Applicant respectfully asserts that it is the Examiner that has failed to explicitly set forth a proper basis for the rejection. In the latest rejection, the Examiner **does not address** the claim limitation that the coupled inductors have a coupling coefficient of at least 0.99. While rejecting Claim 1 based on Qian at various times under 35 U.S.C §102(b) or §103, the Examiner has consistently failed to address Applicant's arguments that Qian cannot and does not disclose tightly coupled inductors having a coupling coefficient of at least 0.99. At various points, the

Examiner has argued that this limitation is disclosed in Qian or that it is inherent in Qian (citing secondary references to support inherency). None of these positions can be supported.

There is no explicit description of the coupling coefficient in Qian. The Examiner tacitly admits this point in the Remarks of the August 15, 2005 Office Action. There, the Examiner relies upon inherency for this limitation and then relies upon the Stratton reference (U.S. Pat. No. 4,273,051) to support inherency, as will be discussed further below.

The claimed coupling coefficient is not inherent in Qian. As described above, Qian is directed to solving problems associated with coupled inductors having significant leakage inductance and thus **teaches away** from the use of coupled inductors with the claimed coefficient of coupling. Therefore, this limitation is not inherent in Qian for at least this reason.

In prior rejections, the Examiner asserted that having a coefficient of coupling greater than or equal to 0.99 "is an inherent feature of the most basic principle of all transformer design". To support this conclusion, the Examiner has relied upon either the Stratton reference or a textbook by Hayt and Kemmerly, "Engineering Circuit and Analysis" at pages 442-443.

The textbook **does not support** the Examiner's position for at least two reasons. First, the textbook states that "an ideal transformer is a useful approximation of a **very tightly** coupled transformer in which the coefficient of coupling is almost unity and both the primary and secondary inductive reactances are extremely large in comparison with the terminating impedances." (Emphasis Added). This statement **does not** support the conclusion that **ALL** transformer designs include tightly coupled transformers. Rather, this statement supports the idea that **WHEN** a tightly coupled transformer **IS** used, an ideal transformer is a reasonable approximation.

As was discussed above, the inductors in Qian do not appear to be tightly coupled as

shown in FIGs. 2, 3e and 4 of Qian. Therefore, **since** Qian does not appear to include tightly coupled inductors, the ideal transformer is **not** necessarily a useful approximation.

In another Office Action on August 15, 2005, the Examiner relied upon the Stratton reference to supply this teaching. **See** Remarks, Office Action August 15, 2005. Applicant correctly pointed out that **Stratton expressly recommends coefficients of coupling K in the range of 0.5 to 0.9**. See Col. 5, lines 48-51. Thus, Stratton teaches away from the claimed invention. In addition, Stratton also supports the idea that there are a wide variety of other suitable coefficients of coupling in voltage regulators.

The fact that a certain characteristic **may occur or be present** in the prior art reference is not sufficient to establish inherency of that characteristic. ***In re Rijckaert***, 28 USPQ2d 1955, 1957 (Fed. Cir. 1993) (emphasis added). The Federal Circuit has clearly stated that:

> To establish inherency, the extrinsic evidence 'must make clear that the missing descriptive matter is **necessarily** present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill. Inherency, however, may not be established by probabilities or possibilities.'

In re Robertson, 49 USPPQ2d 1949, 1950-1951 (Fed. Cir. 1999) (emphasis added).

"In relying upon the theory of inherency, the examiner must provide a basis in fact and/or technical reasoning to reasonably support the determination that the allegedly inherent characteristic **necessarily** flows from the teachings of the applied prior art." ***Ex Parte Levy***, 17 USPQ2d 1461 (Bd. Pat. App. & Inter. 1990) (emphasis original). Therefore, the coupling coefficient of that is greater than or equal to 0.99 must **necessarily flow** from the teachings of the Qian reference. **Applicant respectfully asserts that this is not the case here.**

The Examiner further alleges that it would be obvious to one of ordinary skill in the art to use a transformer coefficient coupling of equal or greater than 0.99 "since it has been held that

discovering an optimum value of result effective variable involves only routine skill in the art." See Page 5 of the Office Action mailed October 19, 2007. Applicants respectfully note that before a determination of an optimum range can be characterized as routine experimentation, **the parameter must first be recognized as a result-effective variable**. See MPEP § 2155.05 II. B. Applicants respectfully submit that the Examiner fails to establish, or provide any evidence, that a transformer coefficient coupling is a result effective variable in the context of the Qian reference. Instead, the Examiner merely alleges that it would be obvious to one having ordinary skill in the art because it "involves only routine skill in the art."

Further, as described above, Qian is directed to solving problems associated with coupled inductors having significant leakage inductance. Here again, the entire purpose of the improvement of Qian was to add the additional components to the prior art circuit of FIG. 2 to compensate for the leakage inductance L_k and to handle the voltage spikes that arise in the prior art circuit of FIG. 2. Thus, Qian teaches away from the use of coupled inductors with the claimed coefficient of coupling and instead provides an altogether different solution.

Applicant respectfully asserts that Qian **teaches away** from using tightly coupled inductors. Furthermore, tightly coupled inductors are **not inherent** in the Qian disclosure. Therefore, the Examiner has failed to properly support his rejection under 35 U.S.C. §103 for at least these reasons.

There are additional reasons why Claim 1 is novel and nonobvious. As admitted by the Examiner, Qian fails to show, teach or suggest the first winding has a number of turns N1, the second winding has a number of turns N2, and a turns ratio N1/N2 is set to a predetermined value of at least two. The use of the claimed turns ratio provides particular advantages in the claimed circuit as will be described below.

Other than showing a 2:1 turns ratio of a transformer, the circuit of Lu et al. has **no other similarity to the circuit shown in Qian**. Applicant respectfully asserts that the Examiner is using hindsight in making this combination.

The alleged motivation is to "provide a simplistic approach to control the output voltage and output current induced in the secondary by changing the turns ratio of the transformer." This brief explanation falls far short of the type of **explicit analysis** that is required by the Supreme Court in **KSR Int'l v. Teleflex Inc.**, 550 U.S. ____ (2007). This explicit analysis and reasoning must be supplied by the Examiner absent an express teaching or suggestion in the references for making the combination. **Id.** The Examiner's failure to provide a proper basis for picking and choosing prior art references is fatal to his obviousness arguments.

In prior rejections, the Examiner also alleged that there was no particular advantage to the use of the claimed turns ratio. As will be described below, there are significant unexpected advantages to using the turns ratio in this circuit. Applicant described the particular purpose and advantages of the claimed turns ratio in this particular circuit in the specification as filed:

> **[0021]** ... With a turns ratio of 2, the duty cycle of the voltage regulator is approximately two times greater than the duty cycle for the standard topology buck converter, the current flowing through the coupled inductor 36a is approximately one-half the amplitude, and the voltage impressed across the drain-source of the freewheeling switch 34a is less than the voltage impressed across the drain-source of the standard topology buck converter. The voltage impressed across the drain-source of the freewheeling switch 34a is approximately, $Vds \cong (Vin - Vout) * \left(\frac{N2}{N1 + N2} \right) + Vout$. In contradistinction, in a standard topology buck converter the voltage impressed across the drain-source of the freewheeling switch is approximately, $Vds \cong Vin$.
>
> **[0022]** Therefore, the freewheeling switch 34a may be selected to have a lower withstanding voltage, Vds; and by using a similar die size to what a standard topology switch would use, the Rds(on) for the freewheeling switch 34a may also be lower.

Therefore, the use of the tightly coupled inductors simplifies the voltage regulator circuit. Furthermore, using the claimed turns ratio may allow the freewheeling switch to have a lower withstanding voltage. By using a similar die size to what a standard topology switch would use, the Rds(on) for the freewheeling switch may also tend to be lower.

Claim 1 is therefore allowable over the prior art of record. Claim 11 is allowable for at least similar reasons as Claim 1. The remaining Claims are either directly or indirectly dependent upon allowable Claims 1 and 11 and are therefore allowable for at least similar reasons.

B. The Examiner's rejection of Claims 7 and 17 under 35 U.S.C. § 103(a) as being unpatentable over Qian in view of Lu et al and further in view of Beckman et al. (U.S. Pat. No. 6,184,666) is improper and should be withdrawn.

Applicant incorporates the arguments set forth above in section A and respectfully asserts that Claims 7 and 17 are allowable for at least similar reasons as those set forth for Claim 1 and 11.

C. The Examiner's rejection of Claims 10, 22, 20, 24 under 35 U.S.C. § 103(a) as being unpatentable over Qian in view of Lu et al and further in view of Yang et al. (U.S. Pat. No. 6,404,175) is improper and should be withdrawn.

Applicant incorporates the arguments set forth above in section A and respectfully asserts that Claims 10, 22, 20 and 24 are allowable for at least similar reasons as those set forth for Claim 1 and 11.

D. The Examiner's rejection of Claims 8, 18 and 25-29 under 35 U.S.C. § 103(a) as being unpatentable over Qian in view of Lu et al and further in view of Dwelley et al. (U.S. Pat. No. 6,166,527) is improper and should be withdrawn.

Applicant incorporates the arguments set forth above in section A and respectfully asserts that Claims 8, 18 and 25-29 are allowable for at least similar reasons as those set forth for Claim 1 and 11.

In addition to the foregoing arguments, with respect to Claim 26, none of the references show, teach or suggest using a freewheeling switch that has a lower withstanding voltage than a conduction switch. With respect to Claim 27, none of the references show, teach or suggest the freewheeling switch and the conduction switch are Field Effect Transistors and the freewheeling switch has a lower Rds(on) than the conduction switch

Switches that have a lower withstanding voltage typically have a lower Rds(on) or Vce(sat) than a switch with a comparable die size and a higher withstanding voltage. The lower Rds(on) or Vce(sat) may result in lower conduction losses. In addition, the switching losses may also be lower due to the lower voltage impressed across the freewheeling switch.

Therefore, Claims 26 and 27 are allowable for at least these reasons. Claims 28 and 29 are allowable for at least similar reasons as Claims 26 and 27.

VIII. Conclusion

For the reasons presented above, the rejections of the claims are not properly founded and should be reversed.

Respectfully submitted,

HARNESS, DICKEY & PIERCE, P.L.C.

Date: 3/18/08

By: _____

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APPENDIX A

Claim Listing:

1. (Previously Presented) A voltage regulator for generating an output voltage from an input voltage, comprising:

at least one coupled inductor including a first winding and a second winding each having a polarity, the first winding and the second winding connected in series to form a common node and such that the first winding and the second winding have the same polarity, the first winding and the second winding having a coefficient of coupling greater than or equal to 0.99;

a conduction switch having an on-state and an off-state, to controllably conduct the input voltage to the at least one coupled inductor at a switching frequency; and

a freewheeling switch having an on-state and an off-state, in communication with the common node of the at least one coupled inductor to provide a path for current when the conduction switch is in the off-state,

wherein the first winding has a number of turns N1, the second winding has a number of turns N2 and a turns ratio N1/N2 is at least two.

Claims 2-3 (Cancelled).

4. (Original) The voltage regulator of Claim 3 wherein the turns ratio is approximately two.

5. (Original) The voltage regulator of Claim 1 wherein the coupled inductor is formed on a single core of magnetic material.

6. (Original) The voltage regulator of Claim 1 further comprising an output capacitor in communication with the at least one coupled inductor to filter the output voltage.

7. (Original) The voltage regulator of Claim 1 wherein the conduction switch includes parallel independently controlled switches.

8. (Original) The voltage regulator of Claim 1 further comprising a multi-level gate drive to control the conduction switch.

9. (Original) The voltage regulator of Claim 1 wherein the freewheeling switch is selected from a group consisting of uni-directional switches, bi-directional switches, diodes, rectifiers, synchronous rectifiers, FETs, NMOS, PMOS, BJTs, and IGBTs.

10. (Original) The voltage regulator of Claim 1 further comprising at least another voltage regulator connected in parallel with the voltage regulator.

11. (Previously Presented) A voltage regulator for generating an output voltage from an input voltage, comprising:

at least one coupled inductor including a first winding and a second winding each having a polarity, the first winding and the second winding connected in series to form a

common node and such that the first winding and the second winding have the same polarity, the first winding and the second winding having a coefficient of coupling greater than or equal to 0.99;

means for conduction switching having an on-state and an off-state, to controllably conduct the input voltage to the at least one coupled inductor at a switching frequency; and

means for freewheeling switching having an on-state and an off-state, in communication with the common node of the at least one coupled inductor to provide a path for current when the conduction switching means is in the off-state,

wherein the first winding has a number of turns N1, the second winding has a number of turns N2 and a turns ratio N1/N2 is at least two..

Claims 12-13 (Cancelled).

14. (Original) The voltage regulator of Claim 13 wherein the turns ratio is approximately two.

15. (Original) The voltage regulator of Claim 11 wherein the coupled inductor is formed on a single core of magnetic material.

16. (Original) The voltage regulator of Claim 11 further comprising means for filtering in communication with the at least one coupled inductor to filter the output voltage.

17. (Original) The voltage regulator of Claim 11 wherein the conduction switching means includes parallel independently controlled switches.

18. (Original) The voltage regulator of Claim 11 further comprising a multi-level gate drive to control the conduction switching means.

19. (Original) The voltage regulator of Claim 11 wherein the freewheeling switching means is selected from a group consisting of uni-directional switches, bi-directional switches, diodes, rectifiers, synchronous rectifiers, FETs, NMOS, PMOS, BJTs, and IGBTs.

20. (Original) The voltage regulator of Claim 11 further comprising at least another voltage regulator connected in parallel with the voltage regulator.

21. (Original) The voltage regulator of Claim 1 wherein the conduction switch is selected from a group consisting of Field Effect Transistors (FETs), NMOS, PMOS, Bipolar Junction Transistors (BJTs), and Integrated Gate Bipolar Junction Transistors (IGBTs).

22. (Original) The voltage regulator of Claim 10 further comprising a phase generator in communication with each of the voltage regulators to control a phase sequence of the voltage regulators.

23. (Original) The voltage regulator of Claim 11 wherein the means for conduction switching is selected from a group consisting of Field Effect Transistors (FETs), NMOS, PMOS,

Bipolar Junction Transistors (BJTs), and Integrated Gate Bipolar Junction Transistors (IGBTs).

24. (Original) The voltage regulator of Claim 20 further comprising means for phase controlling in communication with each of the voltage regulators to control a phase sequence of the voltage regulators.

25. (Original) The voltage regulator of Claim 1 further comprising a controller to control the on-time of the conduction switch such that the output voltage is regulated to a predetermined amplitude.

26. (Original) The voltage regulator of Claim 1 wherein the freewheeling switch has a lower withstanding voltage than the conduction switch.

27. (Original) The voltage regulator of Claim 1 wherein the freewheeling switch and the conduction switch are Field Effect Transistors and the freewheeling switch has a lower Rds(on) than the conduction switch.

28. (Original) The voltage regulator of Claim 11 wherein the means for freewheeling switching has a lower withstanding voltage than the means for conduction switching.

29. (Original) The voltage regulator of Claim 11 wherein the means for freewheeling switching and the means for conduction switching are Field Effect Transistors and the means for freewheeling switching has a lower Rds(on) than the means for conduction switching.

APPENDIX B Evidence Appendix

A copy of the Office Action mailed October 19, 2007 is attached.

APPENDIX C

There are no related proceedings.

UNITED STATES PATENT AND TRADEMARK OFFICE

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/810,452	03/26/2004	Sehat Sutardja	MP0467	8949

26703 7590 10/19/2007
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EXAMINER	
VU, BAO Q	

ART UNIT	PAPER NUMBER
2838	

MAIL DATE	DELIVERY MODE
10/19/2007	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

5059-000143
OIA f2nd 7
OIPE Due 1-19-2008

D

Office Action Summary

Application No.	Applicant(s)	
10/810,452 MDW	SUTARDJA, SEHAT	
Examiner	**Art Unit**	
Bao Q. Vu	2838	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 5-21-07.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1,4-11 and 14-29 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1, 4-11, 14-29 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

JSS/cw

1. In view of the Appeal Brief filed on 5-21-07, PROSECUTION IS HEREBY REOPENED. New grounds of rejection are set forth below.

To avoid abandonment of the application, appellant must exercise one of the following two options:

(1) file a reply under 37 CFR 1.111 (if this Office action is non-final) or a reply under 37 CFR 1.113 (if this Office action is final); or,

(2) initiate a new appeal by filing a notice of appeal under 37 CFR 41.31 followed by an appeal brief under 37 CFR 41.37. The previously paid notice of appeal fee and appeal brief fee can be applied to the new appeal. If, however, the appeal fees set forth in 37 CFR 41.20 have been increased since they were previously paid, then appellant must pay the difference between the increased fees and the amount previously paid.

A Supervisory Patent Examiner (SPE) has approved of reopening prosecution by signing below:

Hezron Williams

SPE AU2838

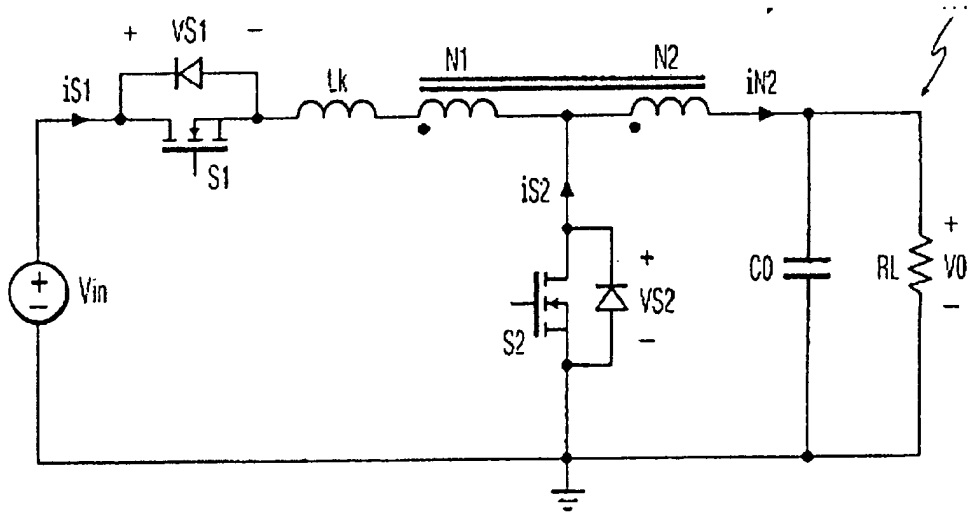
HEZRON WILLIAMS
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

3. Claims 1, 4, 5, 6, 9, 11, 14, 15, 16, 19, 21 and 23 rejected under 35 U.S.C. 103(a) as being unpatentable over Qian (USP 6,512,352) in view of Lu et al. (USP 5,636,107). Qian discloses the claimed invention a coupled inductor with first, N1, and second, N2, windings connected in series to form a common node, a conduction switch, S1, and a freewheeling switch, S2, the inductor is formed on a single core, and an output capacitor, Co. See figure below.



4. Qian discloses the claimed invention except for turns ratios of the inductor devices. Lu discloses that it is known in the art to provide the turns ratios of the inductor devices of having a relationship of the N1/N2 windings of the transformer to be 2. The turns ratio indicates the amount by which the transformer increases or decreases the voltage applied to the primary. For example, if the secondary of a transformer has two times as many turns as the primary, the voltage induced into the secondary will be two times the voltage across the primary. (As is with

the case of applicant's claimed invention). If the secondary has one-half as many turns as the primary, the voltage across the secondary will be one-half the voltage across the primary. However, the turns ratio and the current ratio of a transformer have an inverse relationship. Thus, a 1:2 step-up transformer will have one-half the current in the secondary as in the primary. A 2:1 step-down transformer will have twice the current in the secondary as in the primary. (As is with the case of applicant's claimed invention).

It would have been obvious to one having ordinary skill in the art at the time of the invention was made to provide the turns ratios of the inductor devices of having a relationship of the N1/N2 windings of the transformer to be 2 of Lu with the controlled inductive switching circuit of Qian, in order to provide a simplistic approach to control the output voltage and output current induced in the secondary by changing the turns ratio of the transformer.

2144.05 Obviousness of Ranges [R-1]

>See MPEP § 2131.03 for case law pertaining to rejections based on the anticipation of ranges under 35 U.S.C. 102 and 35 U.S.C. 102 / 103.

OPTIMIZATION WITHIN PRIOR ART CONDITIONS OR THROUGH ROUTINE EXPERIMENTATION

Generally, differences in concentration or temperature will not support the patentability of subject matter encompassed by the prior art unless there is evidence indicating such concentration or temperature is critical. "[W] here the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation." In re Aller, 220 F.2d 454, 105 USPQ 233, 235 (CCPA 1955) (Claimed process which was performed at a temperature between 40C and 80C and an acid concentration between 25 and 70% was held to be prima facie obvious over a reference process which differed from the claims only in that the reference process was performed at a temperature of 100C and an acid concentration of 10%.). See also In re Hoeschele, 406 F.2d 1403, 160 USPQ 809 (CCPA 1969) (Claimed elastomeric polyurethanes which fell within the broad scope of the references were held to be unpatentable there over because, among other reasons, there was no evidence of the

criticality of the claimed ranges of molecular weight or molar proportions.). For more recent cases applying this principle, see Merck & Co. Inc. v. Biocraft Laboratories Inc., 874 F.2d 804, 10 USPQ2d 1843 (Fed. Cir.), cert. denied, 493 U.S. 975 (1989), and In re Kulling, 897 F.2d 1147, 14 USPQ2d 1056 (Fed. Cir. 1990).

ONLY RESULT-EFFECTIVE VARIABLES CAN BE OPTIMIZED

A particular parameter must first be recognized as a result-effective variable, i.e., a variable which achieves a recognized result, before the determination of the optimum or workable ranges of said variable might be characterized as routine experimentation. In re Antonie, 559 F.2d 618, 195 USPQ 6 (CCPA 1977) (The claimed wastewater treatment device had a tank volume to contractor area of 0.12 gal. / sq.ft. The prior art did not recognize that treatment capacity is a function of the tank volume to contractor ratio, and therefore the parameter optimized was not recognized in the art to be a result-effective variable.). See also In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980) (prior art suggested proportional balancing to achieve desired results in the formation of an alloy).

Qian and Lu discloses the claimed invention except for having a transformer coefficient coupling of equal or greater than 0.99. It would have been obvious to one having ordinary skill in the art at the time the invention was made to a transformer coefficient coupling of equal or greater than 0.99, since it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

The extent to which flux generated in one winding links the other winding is expressed in terms of the winding's coupling coefficient: a coupling coefficient of unity (1), implies perfect coupling (i.e. all the flux which links that winding also links the other winding) and an absence of leakage flux (i.e. none of the flux which links that winding alone). From a circuit viewpoint, the effects of leakage flux (inductance) are accounted for by associating an equivalent lumped value of leakage inductance with each winding. An increase in the coupling coefficient translates into a reduction in leakage inductance: as the coupling coefficient approaches unity, the leakage inductance of the winding approaches. Therefore it would have been obvious to one of ordinary skill in the art to use a transformer with coefficient of coupling near unity (optimum

value) if it was possible knowing the inherent inefficiencies of high leakage inductances associated with low coefficient of coupling which were not achievable at the time of the prior art as opposed to the present where high coefficient of coupling are achieved now near unity.

5. Claims 7 and 17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Qian (USP 6,512,352) in view of Lu et al. (USP 5,636,107) and further in view of Boeckman et al. (USP 6,184,666). Qian and Lu disclose the claimed invention (see above paragraphs) except for the independently controlled parallel switches. Boeckman discloses that it is known in the art to provide the independently controlled parallel switches. It would have been obvious to one having ordinary skill in the art at the time of the invention was made to provide the independently controlled parallel switches of Boeckman with the controlled inductive switching circuit having a turns ratio of 2 of Qian and Lu, in order to reduce the heated generated by either switch when in operation to create a redundancy to handled higher voltages and reduces the failure rate of the switches.

6. Claims 10, 22, 20, and 24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Qian (USP 6,512,352) in view of Lu et al. (USP 5,636,107) and further in view of Yang et al. (USP 6,404,175). Qian and Lu disclose the claimed invention (see above paragraph 2) except for the parallel-connected voltage regulators with the phase controller. Yang discloses that it is known in the art to provide the parallel-connected voltage regulators with the phase controller. It would have been obvious to one having ordinary skill in the art at the time of the invention was made to provide the parallel-connected voltage regulators with the phase controller of Yang with the controlled inductive switching circuit having a turns ratio of 2 of Qian and Lu, in order

provide a controlled current sharing and current balancing techniques achieved by utilizing the parallel-connected voltage regulators with the phase controller.

7. Claims 8, 18 and 25-29 are rejected under 35 U.S.C. 103(a) as being unpatentable over Qian (USP 6,512,352) in view of Lu et al. (USP 5,636,107) and further in view of Dwelley et al. (USP 6,166,527). Qian and Lu disclose the claimed invention (see above paragraph 2) except for the on-time conduction controller with multi-level gate driver circuit. Dwelley discloses that it is known in the art to provide the on-time conduction controller with multi-level gate driver circuit. It would have been obvious to one having ordinary skill in the art at the time of the invention was made to provide with the controlled inductive switching circuit having a turns ratio of 2 of Qian and Lu, with the on-time conduction controller with multi-level gate driver circuit of Dwelley, in order to provide a controlled switching scheme that conserves power by driving less than all the switches when the input voltage is higher or lower than the output voltage.

Response to Arguments

8. Applicant's arguments with respect to the claims have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Bao Q. Vu whose telephone number is (571) 272-2088. The examiner can normally be reached on Monday-Thursdays, 8:00AM- 6:00PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Hezron Williams can be reached on (571) 272-2208. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Bao Q. Vu
Primary Examiner
Art Unit 2838

October 11, 2007